Escherichia Coli Infections

Viroj Wiwanitkit

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Preface

"Disease" is something no one desires. However, the disease is a serious thing that cannot be totally avoided in a human life. Disease is important thing in medicine. An important problem of the world is "disease". No one denies the importance of the disease. An important group of diseases calling infectious diseases are still big global public health concern. The important disease at present is a bacterial diarrhea due to *E. coli* that is widely spread in the present year (2011). The problem started in Western countries where the settings are considered to have good hygiene. The infection becomes a widespread problem and very important in the present day. Preparedness and response to outbreaks of this disease that may occur in any country is important concern. Knowledge about the disease, *E. coli* infection, is interesting thing to realize. This book was compiled with this disease, *E. coli* infection, in its entirety. Data on a clinical presentation, diagnosis and treatment are hereby presented. Also issue on disease protection is also offered for interested readers. The concept of food security is also provided as supplementary. This book is suitable for all ages, for those who love and want to distantly draw themselves from this disease. You should not miss to read this book.

Professor Viroj Wiwanitkit, M.D.

What is *E. coli*?

Familization with ***E. coli*** [1 -4]

The "*E. coli*" may be a new vocabulary that many people would be unfamiliar to them. This word is the name of the disease that is a major problem and concern in global health that still presents as outbreaks in many countries, especially those in Europe. *E. coli* infection is a bacterial disease caused by a pathogenic bacterium namely Escherichia coli.

Bacteria are not usually problematic. Some are useful. Bacteria are well known as single-celled organisms known as microbes or microorganisms. In biological organisms, we can classify them in groups that we called "prokaryote".

As noted, bacteria are living thing. It is usually very small. Its size is one-thousandth of a millimeter. Bacteria have a variety of shapes from round to bar and spiral form. The most common living thing in our world is bacteria. There are a variety of habitats on bacteria on earth. Bacteria are able to grow anywhere in any conditions. The growth of the bacteria can be found in soil, acidic hot springs, waste water, in the sea bottom and in the volcano. Also, it is the microscopic species that can inhabit in the body of plants and animals. The bacteria is believed to be the first living amongst any living things that appears on earth.

The bacteria is found in general including:

- in the air.
- in fresh water
- in the salt sea
- in hot water
- in the crater
- the deep sea
- in the ground
- high atop a hill covered with snow.

- in the plant
- in the animal
- in helminths
- in our body.

The important characteristics of the bacteria included

- Bacteria are single-celled living things.
- Bacteria can find and makes its own food. It has complete metabolism including to reproduction and propagation of cells that interacts within the cell.
- Bacteria are too small to be seen by naked eye, has to be visualized with a light microscope.
- There is no nucleus in bacteria
- In biology, bacteria are called prokaryotes (Pro = before, karyote = nucleus).

As I wrote that the bacteria have many different shapes, bacterial can be divided by the shape into three groups.

A bar (bacillis) such as Lactobacillus bacteria.

Spherical (cocci), such as those casue infections of the throat or those casue inflammations of the skin.

Helix (spirochete) such as those casue syphilis and leptospirosis infections

In microbiology, bacteria can be classified into two major groups:

- Eubacteria.

Bacteria in general

- Archaebacteria or extremophiles

By definition, it is a bacterium that has a special feature. It can be seen in the presence of labile environmental changes such as in hot spring and in the crater. These bacteria are accounted about 5 percent of all existing bacteria. It is believed that this group of bacteria is the oldest and most primitive in the world.

The question impressing in mind of many people is “Do all bacteria cause disease or not?”

In fact, the answer is “not always”. In fact, there are only about 5 percent of the bacteria that cause disease. (a specific medical pathopen). The other parts of the remaining 95 per cent do not cause disease and may be useful for us.

The simple examples to help understand this:

- help to prevent certain problem on the skin
- help in synthesis of vitamin K in the intestines

- help digest food (sheep and cattle)
- use in cooking, such as
  - pickles.
  - sausage
  - cheese.
  - milk, yogurt, sour
- use as medicine
- beneficial to plant life (at the roots of plant that helps hold the nitrogen)

However, many people may still wonder how the bacteria can cause disease. The reasons include

- due to biochemical reactions in the body against plants, animals and humans cellular structurs
- create a product that is harmful to living things, toxins. (*E. coli* toxin is a good example).
- some bacteria directly attacks to the tissues of other living things.
- a mutation of the bacteria makes its appearance and shape that is changed from the original form causing virulence
- intention to desing, put and use bacteria as a weapon. (Bioterrorism)

However, the disease must fulfill the medical requirements, must be based on three main physiological factors including:

- There are pathogen
  - destroy good health
  - cause disease.
  - plenty enough (appropriate dosage)
- There are people who are infected.
  - must be weak
  - exposed to infection.
  - immunity is not good enough
  - with good resistance to bacteria but bacteria is highly pathogenic and virulent
- the surrounding environment
  - contributing to the infection
  - found in the same place.
  - and at the same time.

We'll call these requirements as "epidemiological triad"

As I have already mentioned, there are thousands of species of bacteria. In microbiology, medical scientist classified groups of bacteria based on the clinical laboratories finding as a criterion for the division

The criteria that are widely used:

1. Divided by type of energy that the bacteria use to survive

   This classification help divide bacteria into the following groups

   1.1 bacteria that use light energy (Photosynthesic bacteria)
   These bacteria can synthesize their own food using light. This is similar to plants or algae.

   1.2 bacteria that use energy from chemical reactions. (Chemotrophic bacteria)
   The chemical reaction that are used can be classified into two types.

   - Chemical reaction of inorganic substances (sulfur bacteria that found in the hotspring)
   - Chemical reactions of organic compounds.

2. The motion.

   This classification help divide bacteria into the following groups

   - Bacteria that are not moving
   - Bacteria that move through the sliding (gliding)
   - Bacteria that are mobile based on the specific build up of bacteria that resembles a feather or a tail whip, called the flagella of bacteria. The moving of this group of bacteria is the fastest. By the microscope, it is called "running" (For example: bacteria that cause cholera infections)

3. The shape and arrangement of the cell

   This classification help divide bacteria into the following groups

   - Bar (rod).
   - Round or oval shaped (cocci).
   - Spiral (spirochete).

In addition, each bacterial species has a specific characteristic arrangement of cells. This pattern can be used to identify a group of bacteria as well

- as a long chain
- as a single cell.
- as a couple (such as gonococci)
- as a grape like appearance (such as bacteria that cause abscess or pus)

4. The staining of the cell wall

   This classification help divide bacteria into the following groups

   - Bacteria that the cell wall staining with a blue dye, known as gram positive

- Bacteria that the cell wall staining with a red dye, known as gram negative

5. The demand for oxygen to sustain its life

   This classification help divide bacteria into the following groups

   - Bacteria that requires oxygen (aerobic bacteria)
   - Bacteria that can live without oxygen (anaerobic bacteria)
   - Bacteria that can grow in conditions with little oxygen
   - Bacteria that can grow in conditions with and without oxygen (facultative).

To use or not use oxygen are important. Many people mistakenly think that if there is no oxygen for the bacteria, it will die like a man. The problem is that we come across very often. Contamination of canned food which resulted in a substantial growth of pathogenic bacteria is the good example of problematic condition due to this misunderstanding.

6. Based on spore production

   This classification help divide bacteria into the following groups

   - The spores production is possible

Some bacteria, when in suitable conditions such as malnutrition or be triggered by chemical or physical factors, can sporulate. This group of bacteria is resistant to environmental insult. However, the spores of bacteria are different from those of fungi and plants. It does not function as a reproductive unit as those spores of fungi and plants. But the bacterial spores are the armors for protection. The spores are very important. It helps resist to antiseptic. Simply, bacterial spores cause disease.

   - The spores production is not possible

This group of bacteria cannot sporulate. So it is very drug - susceptible organism. Environment can be destroyed easily.

For *E. coli*, it is classified into the group of "Enterobacteriaceae". The main characteristics of the Enterobacteriaceae are as followings

1. Morphology and physiology.

   Small

   Placed in the Gram-negative group

   Can not sporulate

   Found in the intestine

2. Chemical properties.

   Glucose fermenting

   Acid production

   Reduce nitrate

   Oxidase negative

   Facultative anaerobic

3. Physics

Small

With flagella (However, Shigella and Klebsiella, has no flagella).

No capsule

No mucus layer

The antigen structures play an important role for identification of Enterobacteriaceae.

- K antigen (in capsules)

  Capsule is a compound in the group of polysaccharide.

- H antigens (of flagella)

  It is specific protein of the flagella. (So it can not be found among the genera of nonmotile bacteria, Shigella and Klebsiella).

- O antigen (the cells or the body)

  It is a substance in the group of lipopolysaccharide and polysaccharide. It is highly specific characteristic.

The medical scientist will use these properties for classifying bacteria into group or to make "taxonomy".

Althought there are many specifies of Enterobacteriaceae, few speciesare considered important and can cause disease. The pathogens that are important in medicine include:

- Salmonella
- Yersinia
- Some species of bacteria Escherichia coli

  ETEC

  EIEC

  EPEC

  EHEC

  EaggEC

  UPEC

E. coli is a bacteria that is shaped as a bar and classified as a facultative anaerobe. Its appearance in the colonies on EMB agar plates are as the followings

Small to medium

Dark green and glossy

Raised

Polish

Circle

The biochemical specificity are as followings

Indole production (+).

Methyl red (+).

Voges-Proskauer (-).

Citrate utilization (-).

Urease (-).

Oxidase (-).

E. coli can be accommodated without causing disease in humans. It can naturally be found in the human intestine. But there are strains that can cause disease. In individuals with healthy immune status, *E. coli* can cause many diseases including:

- gastrointestinal diseases
- urinary tract infections
- bacterial infection in the bloodstream
- meningitis

The type of ***E. coli*** [5]

E. coli is a bacteria that was discovered and named after Theodor Esherich. It is classified into the group of Gram-negative bacteria. It is in the same group as any other bacterial species that are well known in medicine such as

Bordetella pertussis

Borrelia burgdorferi

Chlamydia trachomatis

Helicobacter pylori.

Haemophilus influenzae

Klebsiella spp

Legionella spp

Neisseria gonorrhoeae

Neisseria meningitidis

Shigella spp

Treponema pallidum

Vibrio cholerae

Yersinia pestis

As described, *E. coli* is is an important bacteria which are members of the Enterobacteriaceae. The characteristics are summarized as followingL

- It is a Gram-negative bacteria
- do not generate spores
- 1-2 microns x 30-30 micron (1 micron = 0.001 mm).
- living movement
- can be grown easily at 37 degrees Celsius.

Normal human intestine contains *E. coli* that are not infective. There are approximately 1 kg of bacteria in the intestine. The presence of these bacteria in our intestines is necessary and beneficial to health:

- Helps digestion and composting food waste
- synthetic vitamins that are absorbed by the body, such as vitamin K and vitamin B complex

Normal human intestinal *E. coli* are found to be non-pathogenic. (In fact, in a variety of intestinal bacteria are all non pathogenic). But the disease due to the *E. coli* can also be seen. The *E. coli* bacteria can come out with the feces and cause disease. Although it is outside the intestine *E. coli* can live normally in the water and can survive quite well with it. Since *E. coli* is detectable in the intestine, hence, if detected in the water or food, it means that water or food is contaminated with feces. So the detection of *E. coli* in this case, it indicates the poor sanitation. In public health, detection for *E. coli* in food or water is important in sanitation surveillance. The index indicates the biological contamination.

- Total Coliform Bacteria

  Coliform bacteria is an indication that the water has been contaminated with dirt or bacteria from human feces or other environments.

- Fecal Coliform Bacteria

  It is an indication that water has been contaminated by dirt or bacteria from human feces. (So the value of total coliform bacteria is greater than or equal to the fecal coliform bacteria).

At present, the classification of different strains of *E. coli* is based on serological classification system by different antigens that are unique to each species. The classification is based on major antigens as mentioned above.

- antigen O
- antigen H
- antigen K

Although most of the *E. coli* are harmless and beneficial there are many species that have the ability to cause disease (the medical terminology, enterovirulent *E. coli*). Those pathogen genic *E. coli* could be divided into groups according to the mechanism of pathogenesis.

1. EHEC.

   This group causes haemorrhagic colitis and can end up with a specific complication called uremia haemolytic syndrome. *E. coli* strains in this group included O157: H7 and O104: H4 (which is the present problematic *E. coli* causing outbreak in Europe).

2. EIEC (or sometimes called STEC).

   This group causes diarrhea.

3. ETEC

   This group is a major cause of traveler's diarrhea and diarrhea in group of infants in developing countries. *E. coli* toxic products from the gut causes problems to the patient's body.

4. EPEC

   This group is a major cause of diarrhea in infants

5. EAEC

   This group is a new pathogen.

The species that are medically important and should be discussed include:.

1. O157: H7 [6]

   E. coli O157: H7 *E. coli* is an important and well -known. It cause the problems of small outbreaks around the world. It is very important since this specific *E. coli* may result in severe infection and cause many major complications including to

   - hemolysis
   - renal failure

     That called "HUS" (hemolytic uremic syndrome)

     The nature of the infection is as followings:

     - It is a Gram-negative bacteria
     - do not generate spores
     - 1-2 microns x 30-30 micron (1 micron = 0.001 mm)
     - can be grown easily at 37 degrees Celsius
     - classified as EHEC
     - The O antigen is 157
     - The H antigen is 7
     - can create toxin called shiga like toxin.
     - Horse fly can be the vector of this *E. coli*

This species causes serious disease and can be found naturally in the intestines of cattle, buffalo. The problem of disease is often caused by contaminants in food. The contamination is often found in raw meat. It can also be found in raw milk, raw sausages and vegetables.

Diagnosis of infection with *E. coli* O157: H7 infection is important. The fecal culture helps classificaiton. In suspected watery diarrhea caused by *E. coli* O157: H7, doctors must determine the possibility of occurrence of this infecitont. In practice, the disease is suspected when patients with severe diarrhea and blood in the stool (which is the main symptom of infection, the EHEC), together with epidemiological evidence that an outbreak of *E. coli* O157: H7 is in that area.

2. O104: H4 [7 – 8]

E. coli O104: H4 *E. coli* is an important and well known at present. It is the problem throughout Europe in the present outbreak. (In fact, the incidence of infection has been reported in Korea in the past few years, but it was not a big outbreak).

The nature of the infection is as followings:

- It is a Gram-negative bacteria
- do not generate spores
- 1-2 microns x 30-30 micron (1 micron = 0.001 mm)
- can be grown easily at 37 degrees Celsius
- classified as EHEC
- The O antigen is 104
- The H antigen is 4

Diagnosis of infection with *E. coli* O104: H4 must be based on feces examination. The fecal culture is required. In suspected watery diarrhea caused by *E. coli* O104: H4, doctors must determine the possibility of occurrence of this infecitont. In practice, the disease is suspected when patients with severe diarrhea and blood in the stool (which is the main symptom of infection, the EHEC), together with epidemiological evidence that an outbreak of *E. coli* O104: H4 is in that area.

However, as mentioned above there are several advantages of the *E. coli*. The good examples are

- help digestion.
- as a tool for genetic engineering
- It was reported that toxin secreted from *E. coli* might be useful in fighting cancer cells

The present problematic **outbreak** [7 – 8]

Outbreak is an important situation in medicine. There are several outbreaks of disease within the past 10 years. There are many new outbreaks and usually global problems. Some diseases can kill many people around the world.

The outbreaks that are well-known include

- SARS
- bird flu.
- swine flu in 2009.
- and the lastest strain of *E. coli* O104: H4

We can see that disease outbreaks can be classified into two common groups

1. Respiratory diseases such as

   Cold

   Bird flu

   Swine flu

   SARS

2. Gastrointestinal diseases such as

   Typhoid

   Paratyphoid

   E. coli disease

There are many diseases that can cause outbreaks all around us. Hence, we need to know about the disease in order to prevent it. In epidemiological aspect, the conditions that are required for outbreak include:

- There is a disease

  The disease is an illness or disorders or unwanted occurrence. It will not be considered an outbreak if it is a good thing or provides health benefits.

- There are a lot of infected cases

  In science, the definition of outbreak or epidemic is very clear that this was more than 2 times the average rate of the disease plus two times the standard deviation of the rate of disease. IT can be presented as a mathematical equation

  "> X + 2SD"

- There are lots of diseases

  This may be associated with the climate or season, such as dengue fever is common in the rainy season.

- The disease more often than usual

  If an infection usually occurs, it is referred as endemic. It is a fundamental problem to be solved locally. It is not new and no need for urgent management. This is totally different from outbreak.

- There are a lot of cases or patients at the hospital

  Outbreaks are more likely to pose a problem to the local hospital. Patients need more treatments. Many cases will visit to the hospital or clinic at the outbreak period and this can be consecutive.

- It can cause deaths as well

  This issue is very important. Disease outbreaks may occur but might not be serious and the patients may be cured. However, some ooutbreak cause severe illnesses and death occur. In the event of an outbreak of *E. coli* infection at present, it is severe and cause of death.

These conditions have to be fulfilled when there is an epidemic

- have the disease
- have the people
- have the interactions between pathogens and the sick case
  - in the same place
  - at the same time.
  - The patient is exposed to germs to gain infection

Outbreaks of E.col infection in the present day is the latest global level epidemic. It is also the first worldwide gastroenterology disorder outbreak in this millennium. This problem is the global public health threat. The present situation has its origin in Europe. Currently, an outbreak is ongoing. The pathogen that causes the pandemic at present is the *E. coli* strains of Escherichia coli O104: H4, a new species that ever caused small outbreak in Korea before.

The outbreak of this bacterial infection firstly appeared in Germany. The outbreak started in May this year (2011). The initial reports mentioned that an outbreak of gastrointestinal disease had occurred. Early reports indicate that the infection was caused by some strains of *E. coli*. These characteristics were described.

- There are a number of sick people.
- Symptoms of the disease was maily on the gastrointestinal tract.
- Diarrhea was predominant
- The transmission of diseae was through food.
- It was caused by *E. coli*.
- It was an infection by EHEC.
- This bacterial infection could can lead to serious disease. It could result in the cases with symptoms of HUS have.
- It could be deadly in the worst case.

An attempt to find the source of the outbreak showed that the outbreak might be caused by contamination of pathogens in food and agriculture. It is belived that the food

products from the organic farm are likely to be contaminated and it is likely to be the source of the outbreak this time. However, even when the farms are closed there is still no clear evidence of laboratory confirmation for infection originated from a farm and it is still doubtful whether the present problem came from a farm or not. Because it can not be detected, this story is still a myth. However, it has been reported.

The new results indicated that laboratory found some strains of pathogens in samples from a suspected farm. The problem of contamination in barbecued bean sprouts is believed to be the real, but not confirmed, source of the infection. It is no problem where the original soruce of the outbreak is since it is not important now because the infection generally occurs elsewhere in present outbreak. The situation is a global problem now.

Outbreaks of infection at this time can be considered an outbreak of gastrointestinal disease that has a trend for global pandemic. Indeed, EHEC infection tends to show the threat of infection to many people. There are still a number of infections with rapidly increase over the years. Focusing on the present problem, the outbreak was firstly detected in Germany and still persists at this time (Late June). There were about 4000 infected cases and about 40 deaths or about 1 percent, which is considered very high.

In Germany, the initial source of the disease, the problem is still no completely controlled. Currently, there are reports of cases of infections emerging in many countries such as Switzerland, Poland, Netherlands, Sweden, Denmark, Britain, Canada, Spain and the United States. All indexed patients were believed to have been infected from the German. Some patients have severe symptoms. The patients with severe HUS and other severe symptoms are recorded in more than 100 cases worldwide.

For the present situation of the epidemic around world, there are many reports. The situations are summarized as followings.

1. Europe

    - Germany.

As the initial source of the disease, there is the heaviest outbreak. Patients died, thousands cases were infected. The German outbreak is considered the most dangerous area with high risk of travel to the region.

- Spain

  There are reports of infections in athletes who recently returned from Germany. The patients were admitted to the hospital and reported eating raw fruits and vegetables.

- Sweden

  Many infected patients are reported and deaths are also reported. Majorly, the cases are the group of the tourists who just came back from Germany. It is believed that infection in these patients is associated with an outbreak linked to Germany.

- Austria.

  There are reports of patients who just entered the country from Germany. This is the case of departure of the German people who are infected and firstly show

symptoms in Austria.

- Czech Republic.

  There are reports of patients who were newly arriving American tourists coming from Germany. The Czech Republic has banned the import of cucumber from Spain.

- Denmark

  There are reports on infections in Denmark. Many cases of infections were detected including HUS cases. Severe symptoms could be obsdrved. Denmark has announced cautions about eating raw cucumbers, lettuce and tomato imported from Germany and Spain.

- Finland

  There are reports of infection occurrences.

- France

  There are several reports of infections among people who recently returned from Germany.

- Netherlands

  There are several reports of infections including cases with severe symptoms and HUS.

  These people have a history of travel to visit Germany before the disease occurred.

- Poland

  There are several reports of infections These people have a history of travel to visit Germany before the infection occurred.

- England.

  There are several reports of infections. These people have a history of travel to visit Germany before the disease occurred. The UK tells their citizen to be careful in eating a cucumber imported from Germany.

- Norway

  The report on infection is already confirmed.

- Switzerland.

  There are reports of infections as well.

- Finland

  There are reports of infections as well.

- Portugal

  There are reports on suspected cases but it does not get confirmation.

- Luxembourg

There are reports of infections as well.

- Slovakia

  There are reports of infections as well.

- Belgium

  Belgium has banned the import of cucumber from Spain although there is no reported case of sickness.

- Bulgaria

  Bulgaria has banned the import of cucumber from Spain although there is no reported case of sickness.

2. America

- Canada

  There are reports of infections in patients with a history of travel to visit Germany before the illnesses occurred.

- USA

  There are reports of infections in patients with a history of travel to visit Germany before the illnesses occurred.

The problem in this outbreak is related directly to food contamination. It is an issue of raw vegetables such as cucumber, bean sprouts, etc. The Food and Drug Administration (FDA) has recommended for the need to provide surveillance of fresh tomatoes, cucumbers, lettuce and salad oil from areas with outbreaks. The principle is as followings.

- It will not allow any product found to be contaminated to the country.
- If contamination is detected, the control must be urgently done.
- Seek and find more information about the source of the outbreak that is continuing.
- Prepare a plan to protect the health of the general public.

The FDA also has advice on food preparation practices for raw materials, with emphasis on vegetables, with the following suggestions

- Begin with clean hands..
- Wash hands for 20 seconds with warm water and soap before and after cleaning materials.
- Wash again before eating.

This procedure can be used for vegetables produced or grown with organic or natural products in the household or bought from any grocery stores or markets.

The FDA also has advice on storing food, raw vegetables and fruits with the following suggestions.

- Proper storage will affect both the quality and safety.

- Fresh fruits and vegetables (such as strawberries, lettuce, herbs, and mushrooms) can be treated best by storing in a clean refrigerator at 40 degrees Fahrenheit or less.
- Material that is cut or peeled should be refrigerated to preserve all the quality and safety.

Another theme that should be mentioned is that measures to deal with contamination of raw materials from sources of present pandemic. The following measures are proposed.

- During the outbreak, the raw materials need to be quarantined.
- The surveillance by sampling should be done.
- Measure should be set for immediate action upon detection of contamination.

However, such measures are currently being used in many countries. And many countries have banned imports of suspected objects. The examples of those countries are

- Switzerland
- Russia
- Denmark
- Czech Republic
- Belgium
- Austria

Table 1. Some important publications focusing on the present ***E. coli*** O104: H4 outbreak.

Authors	Details
Bielaszewska et al. [8]	Bielaszewska et al. performed genome analysis on the new problematic ***E. coli*** P104: H4 and concluded that "The unique combination of genomic features of the German outbreak strain, containing characteristics from pathotypes EAEC and EHEC, suggested that it represents a new pathotype Entero-Aggregative-Haemorrhagic E scherichia c oli (EAHEC) [8]."
Casey et al. [9]	Casey et al. proposed that "This high rate of progression to HUS was the first indicator that the bacterial cause of illness was not a typical EHEC strain [9]" and concluded that the new problematic ***E. coli*** O104: H4 had acquired genes for the production of Shiga - like toxin [9].
Bielaszewska et al. [10]	Bielaszewska et al. reported that "This outbreak demonstrates that blended virulence profiles in enteric pathogens, introduced into susceptible populations, can have extreme consequences for infected people [10]."
Frank et al.[11]	Frank et al. noted that "In this large outbreak of the hemolytic-uremic syndrome, caused by an unusual strain of Shiga-toxin-producing E. coli, cases have occurred predominantly in adults, with a preponderance of cases occurring in women [11]" and "The hemolytic-uremic syndrome has developed in a quarter of the symptomatic outbreak cases that have been ascertained thus far [11]."

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E. coli infection and treatment of *E. coli* infection

The *E. coli* **infection** [1 - 2]

Mechanism for the pathogenesis of *E. coli* in general is now well known. The disease can be found all over the world. For this infection, it is more common in tropical areas. But there are reports of infections from around the world. It is classified as an important gastrointestinal infection. *E. coli* infection is an example of disease that can be transmitted through diet. Because the infections are mainly due to contaminated food, this can be called as food borned infection. This means the disease occurs when one eat foods that are contaminated with dirt. Because this disease is a disease of gastrointestinal tract that can present diarrhea, it is difficult to distinguish this infection from many other infectious diseases that present with diarrhea as well.

For infection, these criteria have to be fulfilled.

- There must be source of infection.
- It spread through the feces.
- There is fecal contamination of food or water.
- Lack of hygiene is common.
- Eating food contaminated with pathogen is the main thing leading to infeciton
- The body's immune system cannot get rid of the pathogen

For the mechanism of infection, it is a disease with orofecal mode of transmission. It results from bacteria that had been mixed into the food or water and a patient ingest it. Then the patient can get the germ and the pathogenesis starts within the gastrointestinal tract. Generally, it is an acute inflammation of the intestine. And it may be accompanied by symptoms of septicemia in serious case.

However, the degree of infection is vary. There are various kinds of *E. coli* with various pathogenicity including to the group that causes toxic symptoms. However, the infec-

tion can result in septicemia, the pathogen will be isolated from stool and blood. In the acute phase, the isolation of the pathogen is possible in the case of an intestinal infection. It is possible to detect the pathogen in feces for several days to weeks after onset, but not found in the blood. Moreover, due to various specific symptoms, a variety of complications are reported.

The mechanism of the disease may be different according to each strain of *E. coli*. And this is the important key for classification of *E. coli*.

- ETEC [3 – 5]
  - a lot of toxins, causing diarrhea
  - a lot of water loss
  - stool as watery form
- EPEC [5 – 8]
  - damage to the cells lining the intestine
  - swelling of the intestinal tract, causing ulceration of the intestines through it
  - a lot of diarrhea
  - a lot of water loss
- EHEC [9 – 13]
  - damage to the cells lining the intestine
  - swelling of the intestinal tract, causing ulceration of the intestines through it
  - a lot of toxins, causing diarrhea
  - affect the blood system, result in bleeding.
  - a lot of water loss

For infection, which is a major problem today is, the outbreak is due to the strain namely O104: H4. This *E. coli* infection is a kind of EHEC based on its pathogenesis and the symptoms that are described at all (which is considered a serious infection that is deadly.)

For the outbreak, the present specific, the O104: H4, is an infection through food. But it is very interesting because of this epidemic firstly occurred in developed countries. In those countries, populations usually have good health status and sanitation. Problems are so different from those seen in the general case in developing countries.

The characteristics in general cases include

- occur in developing countries.
- basic hygiene is poor
- relating to the poor toileting
- often the cause of the slum
- often due to a contamination directly into water or food

The characteristics in present cases include

- occur in developed countries
- good basic hygiene
- no relation to the poor toileting
- relating to organic farming
- contaminated salad is the problem
- natural fertilizers is of concern (Indeed, organic farming is a new agriculture that is becoming very popular. This can bring a risk to health as well.)

Moreover, it is noteworthy that *E. coli* infection can be seen in the community. However, there are many reports of infections in hospitals, the nosocomial infection by *E. coli* infection. An infection in the hospital by *E. coli* is the most common worldwide, and can be seen in every hospital. This is a thing to be considered in infectious control. The characteristics of nosocomial infection of *E. coli* include:

- Hospital is a place that is very dirty.
- Plenty diseases are in the hospital. Plenty germs can also be seen
- Several patients live in the hospital.
- The use of bed and equipment by several people cause contamination.
- Often patients cannot help themself in excretion and toileting
- Patients often receive no good health care, no clean thoroughly.
- People, especially those who stay in the hospital so long, heavily expose to the disease.

Signs and symptoms of the **disease**

Signs and symptoms of diseases of *E. coli* infection are similar to those of bacterial infections in general. The prominent symptoms are the followings.

1. Fever
2. Inflammation
   - pain
   - swelling
   - red
   - hot
3. Specific symptoms

   In the case of infections, including *E. coli*, various gastrointestinal symptoms can be seen

- abdominal pain
- diarrhea
- nausea and vomitting

4. Anal output

In the case of *E. coli* infection, diarrhea or excretion via anal canal is significant.

For *E. coli* infection, it generally that can occur in the intestine. However, it can occur outside of the intestine. It is equally common.

A. An infection in the intestine [1 – 13]

The intestinal infection is an infection that is common and can be in many forms. It may be described in brief based on the nature of the pathogens as the followings.

- ETEC
  - o a lot of diarrhea.
  - o a lot of water loss
  - o stools are watery
  - o abdominal pain, not much
- EIEC
  - o a lot of diarrhea.
  - o a lot of water loss
  - o stools are watery
  - o the intestinal tract twound
  - o much pain.
- EPEC
  - o a lot of diarrhea
  - o a lot of water loss
  - o stools are watery
  - o the intestinal tract wound
  - o much pain
- EHEC
  - o a lot of diarrhea
  - o a lot of water loss
  - o stools are watery and bloody
  - o much pain
  - o a common complication is HUS

Conclusively, the pathogenic *E. coli* infection can result in the following common symptoms

- abdominal pain.
- nausea and vomiting
- diarrhea.
- signs of loss of water

  Dry lip

  Sunken eyeball

  Sunken fontanelle (in infant)

  Hypotension

  Dizziness

  Weight loss

  Stupor

  Coma

For the case of present problematic *E. coli*, O104: H4, it is classified as an EHEC. This means the present outbreak is an outbreak of EHEC [14 – 18]. The symptoms can be summarized as followings.

- severe abdominal pain
- diarrhea, which is very common
- stool is often bloody
- vomiting
- there may be fever, but fever is usually not very high.

Most people who get the infection can improve symptoms within 5-7 days, but some patients may have complications. The report found that 1 percent is being developed into HUS, which usually have symptoms of HUS in a week after the onset of diarrhea.

The principal symptoms of HUS include:

- decreased frequency of urination
- anuria in some case
- feel very tired.
- pale due to anemia

For diagnosis, it is clear that there is a need for the diagnosis of the disease. For sure, it is not simple. The stool examination is the most basic diagnostic test. The fecal samples can be analyzed by standard microscopy. For what detected at diagnosis is, blood and white blood cells (mucus) in the stool is common. But the definitie diagnosis will be clear only if the microbiological testing is applied only. This is usually by the culture bacteria. The specific features are described in the foregoing in this book. In addition, when the

diagnosis of *E. coli* is made, it can be further classified to different species based on patterns of O and H antigen as mentioned above.

In addition, the patients are usually children or the elderly without good health status. These groups of patiets are likely to encounter the complications more often than healthy people. However, the most important complication in children is dehydration. The lack of water is the key presentation. The manifestations can be

- dizzy
- low blood pressure
- urination decrease (can be no urination)
- shock
- death in the end

B. Infections that are outside of the intestine

As said, the intestinal infection is not a sold common infection of the intestine. The case of extraintestinal infection is also commonly reported. It is quite common and found in both the community and in the hospital.

The extraintestinal *E. coli* infections that are common include:

- urinary tract infection
- meningitis.
- infection of the heart

1. Urinary tract infections [19 – 25]

Urinary tract infection due to *E. coli* infections are very common and probably more than the other non-intestinal infections (also intestinal infection).

Urinary tract infections from *E. coli* have the following characteristics

- fever
- here are disorders of the urinary tract

Flank pain.

Abnormal urine, cloudy urine, frequent urination.

The diseases that are well known and frequently include:

- urinary bladder infection
- prostatitis
- urethritis
- nephritis (usually presents with flank pain and chill)

For the *E. coli* that cause urinary tract disease, it is classified into the group of UPEC.

Symptoms vary depending on the type and location of infection. The symptoms include:

- Lower urinary infection
- May have a fever.
- Cloudy urine
- Urinary burning
- Nephritis
- High fever
- Chill
- Flank pain
- Cloudy urine

The diagnosis requires detection of infection in the urinary tract. This is accomplished simply by collecting urine for laboratory examination. The initial urine examination that implies suspious infection includes numerous white blood cells in the urine. And it can be confirmed for an infection by *E. coli* detection on culture.

The question of where the pathogen came from can be answered as

- from the bloodstream (rare).
- comes directly from the anus. (more common in females, due to poor cleaning after toileting solution especially for wiping from back to front)

Risk factors and pathogenesis

- to hold urine
- the cleaning up feces with the wrong way
- drink too little water

2. Meningitis [26 – 30]

Meningitis is an infection of *E. coli* outside of the intestine that is common in children. It is the most common in the group of childhood meningitis.

The meningitis due to *E. coli* can present the followings

- fever
- disorders of the brain.
- Headache
- Paresthesia
- Weakness
- Nausea, vomiting
- Stupor
- Confused
- Seizures

Diagnosis of such infection is based on determination of pathogen in cerebrospinal fluid. This is accomplished simply by cerebrospinal fluid examination. Cerebrospinal fluid samples can be collected by lumbar puncture and the cerebrospinal fluid examination can show white blood cells in cerebrospinal fluid. The diagnosis can be confirmed by *E. coli* determination on culture.

The question of where the pathogen came from can be answered as

- from the bloodstream (rare)
- comes directly from the wound

Risk factors and pathogenesis

- congenital anomaly
- age (blood brain barrier is not fully developed in the infant and the pathogen can easily penetrate thorough it)

3. Infection of the heart [31]

Infection of the heart due to *E. coli* infection is rare, but it can be seen and reported in literatures. It may be:

- infection of the pericardium.
- heart valve disease.

Complications of the **disease** [1 - 13]

Infected with *E. coli* typically present as a diarrheal disease.. If diarrhea is serious and too much, the water loss can be a big problem and this is seriously concerned in very small children.

The dangerous signs include

- little loss
  - hungry
  - thirsty
  - dry skin
  - dry lips
- much loss
  - head collapse (in children).
  - shrink
  - stupor
  - decreased urination

- confusion.
- blood pressure drops
- shock
- loss of consciousness
- death

The infection by *E. coli* is generally not serious. However, it can cause outbreak and serious presentation. The complication is common in EHEC infection. A lot of problems are described. Epidemic that is now in Europe is an infection in this group.

The major complications resulting from infection in this group that are frequently found include

- Effects on blood system that result in bleeding

  Bleeding in the gastrointestinal tract

  Platelet destruction

  Hematochezia
- adverse effects on the kidney

  Kidney failure

  Swelling

  Water retention
- Effects on the nervous system

  The symptoms of meningitis as already described

  Lethargy, confusion and seizures

The combination of these symptoms are known as HUS, a complication that is the cause of death. And that is the most important complication for outbreak at this time.

For a diagnosis of HUS patients, except for those described already, it still requires a laboratory confirmation. The laboratory finding that can be found are described as the followings

- the destruction of blood cells
- anemia, decreased hemoglobin
- retention of the BUN and creatinine in the blood
- urine volume decreased
- the urine sediment abnormalities that indicate renal failure.

Treatment of **infection** [1 - 13]

The first question that must be answered before is whether it is necessary or not to treat *E. coli* infection.

The answer is "yes"

- This is not a self limited disease itself.
- The disease is problematic.
- The disease is deadly.
- There are specific medicines to treat them.

As mentioned above, due to infection with *E. coli* is a bacterial infection that can cause severe symptoms, the early diagnosis and early treatment is considered important.

The treatment of *E. coli* infection can be as the following

- drug treatment
- stabilizing
- maintaining and curing
- stop and correct complications

The principle for treatment include

1. Palliative care.

   The treatment to stabilize the patient's condition that is deteriorated dramatically, not the illness.

   - be aware of the loss of water (the symptoms can be controlled if the mineral and water compensation and replacement is adequate since a lot of water loss can be fatal)
   - be careful about the food.
   - monitor state of shock.

2. To treat the symptoms.

   The treatment of symptoms is needed in order to decrease severity of disease.

   - medication to relieve lower abdominal pain
   - the relief of nausea
   - medication to relieve vomiting
   - medication to relieve fever

3. Specific treatment

   This is a use of antibiotics. The most commonly used antibiotics include

   - bactrim (Trimethoprim - sulfamethoxazole)
   - norfloxacin
   - Cipro (ciprofloxacin)
   - azithromycin

   It is usually given for 7 to 10 days.

4. To treat complications.

   On the course of *E. coli* infection, many complications can be seen. This is a point to be concerned especially in the infections that can result in HUS. HUS is a complication that needs intensive care [32]. These treatments are described for management of complications

   - maintain a balance in the body
   - dialysis in patients with renal failure
   - control bleeding
   - the anticonvulsants in the case having seizures

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How to prevent?

The prevention of ***E. coli***[1 – 13]

Because infection caused by *E. coli* is an important issue the preventive medicine concer is very important. Since an illness can cause distress to patients it is important to prevent the disease. Indeed, prevention is better than cure a disease or treatment. The present *E. coli* disease can lead to a wider outbreak more than the current situation, therefore, it is necessary to prevent the disease to go bigger.

Before we know how to prevent disease we should review the risk of the disease before. If we know what the risk is it would be better to prevent it. Risks may arise from several causes including

- placve at risk
  - slums
  - public facilities
  - hospital
  - crowded place

o source of tourists or people from areas with outbreaks. It may be a popular tourist destination. (Especially in tourist spa that could be at risk place for infection to spread as much).

- risk behaviors
  - taking antacids on a regular basis to destroy the acid helps kill bacteria in the stomach
  - he routine use of antibiotics
  - the use of drugs unnecessarily
  - lack of cleanliness, hygiene and defecation management
  - like eating half-cooked food
  - lack of hand washing

- risk patients.
  - patients with malignant tumors
  - who had surgery in the gastrointestinal tract
  - people who have been treated with the immunosuppressive drug
  - those who are physically weak
  - those with malnutrition
  - AIDS.
  - those with blood disorders such as a well known congenital disease, sickle cell.

For the prevention of *E. coli*, the concerp of preventive medicine can be used. This can be done based on the medical principles of preventive medicine. Many people may be wondering how they can protect themselves from infection with *E. coli*. The following simple principles can be used.

1. Primary prevention.

   Make a prevention before the illness occurs. This is a good thing and the best one to do because this mean the cut since the beginning of true problem.

   Activities that fall into the primary prevention of infection including

   - food sanitation
   - the use of sanitary toilets
   - sanitary pets
   - knowledge about the disease
   - received information from health authorities about the disease (health care unit or the villager health volunteer)
   - residual waste disposal
   - maintain the cleanliness of toilets and bathrooms as well (especially for the public toilets)
   - do not touch the patient with diarrhea
   - avoid traveling to the source of the outbreak of the disease unnecessarily
   - no use of antibiotics to prevent disease.
   - also, no vacciation (However, there are reports of attempts to find vaccine that is specific to the present condition for *E. coli* outbreak. To create a vaccine for the prevention of disease is the concerpt for management of any new outbreak. It is believed that this will be achieved soon. And it is a hope to be an important tool in the fight against this emerging disease which is widespread today [14].)

2. To prevent a secondary

   This means an attempt to prevent illness when it is firstly not quite as good. This is because the early treatment usually means more success. To reach this goal, there are two important things.

- an accurate diagnosis to find the disease early.
  - the development of tool for detection in the community level
  - the development of advanced diagnostic methods to confirm the infection
  - diagnostic skills training for health and medical personnel
  - screening system for the disease during the outbreak.
  - disease surveillance system during the epidemic
- provide timely, effective treatment for the patients

3. Tertiary protection.

   This means an attempt to prevent the serious sequelae of the illness. This is a limitation of the problem. The aim is not to have more illnesses and problems, reduce disability or complications to the minimum.

   For the protection in the group of tertiary prevention, it can be as followings.

- The patient must be monitored closely when they get medical treatment.
- The surveillance of complications
  - hemolysis
  - difficulty urinating.
  - anuria
  - swelling
- prevent the spread of the disease to others
- separate the patient from the others, not used thing or eat together
- notify the local health authorities to control epidemic

For those mentioned preventive means, they are only methods in personal and individual protection level. However, it must also take into account the level of the social or community in which the disease may be more difficult to control.

1. Planning policy
   - the public policy response to the outbreak of the disease.
   - rhe transfer plan to the real use
   - the guidelines to deal with the outbreak when it becomes true
2. Preparation.
   - training of personnel at all levels to prepare for an outbreak of disease
   - provide a tool for disease control or localization of the disease
   - a safe place for a case of an outbreak
   - plans to tackle the outbreak.

- the health care system to deal with emergency cases
- have the equipment ready for sterilization
- development of a new knowledge continuously.

In the present situation, although the problem has not yet found in some countries, many countries prepare and set the method for correspondence to the problem. At present, there are many things to be already prepared.

- surveillance of the disease.
  - surveillance, focusing on the tourists

  Screening on the plane.

  Screening at the airport.

It may be difficult. It can not be measured directly from the outside. And a thermostat scanning cannot be used as that of the 2009 flu (in avian influenza cases in 2009, although the use of thermo-scanner is possible, it also found that there are a lot of escapes from this basic screening system.)

  - If there are suspicious cases, monitor closely
  - report system of outbreaksof the disease
- tracking reports of outbreaks of the disease
  - monitoring data from the WHO
  - weekly report for Disease Surveillance in the country

Food **Hygiene** [15 – 22]

Eating is the verb meaning feeding through into the mouth. Then, pass into the throat, esophagus, stomach and the intestines. Eating is something that every human being must be done. In lifetime, we use thoudsands of eatings. The mouth is therefore a required organ for eating.

Problems associated with eating can be present due to a variety of reasons. These problems may be divided into the following ways.

1. The problem with the organs used for food ingestion
2. The problem about the ability of the body in feeding
3. The problem about the amount of food that one ingests
4. The problem with the quality of the food that is ingested

The fourth problem is something that might be greatly missed. Not just the quantity only, quality is something that must be considered in all actions. Quality of food is the same. Eating a diet that is good is needed. However, there are several problems with the

quality of the food. Contamination of many unwanted things such as chemical or biological contaminations can be expected and this is a main problem in everyday life. It is the near but the big problem that many people may not realize.

For the problem of contagious diseases through food, a concern for quality of food is important.

For problems that may lead to poor quality of the food contamination, they can be simple divided into many groups as the followings.

1. Impurities naturally present

   Contamination may exist naturally in food. Bacteria that exist naturally are good examples. The problems exist but people do not know when the food is eaten.

2. Contaimination during storage and preparation

   Often the contamination occurrs during storage and preparation of raw materials. Manufacturing or cooking are important steps to be controlled. Using the principles of food sanitation can reduce the problem of contamination in this step as well.

3. Due to contamination by humans

   Adding of contaminaion to the food can be seen and this is a negligent behavior that indicates a lack of ethics. The aim of this practice might be the increase of price or may even be a crime (assassination by poisoning).

4. Occurs after eating it

   This is rare. This may be caused by certain reactions within the body or due to defects in the human body.

When we talk about the disease through food, there are some main factors that we must consider as the followings

- pathogen
- a source of disease

These things may be sources of disease.

- the natural contaminants
- the excreta of human or animal
- people
- patients
- dirty dishes
  - transmission of the infection from the source of the disease. In many cases of food borned diseases that is transmitted via orofecal route, a matter is “stool”.
  - a stool that is not well treated leading to contamination of feces.
- to the water.

- to the hand and further used for cooking (then transmission to the other ones)
- as fertilizer in growing and watering vegetables in the farm
  - have a food or water that is contaminated with feces to eat or drink
  - lack of cleaning or poor preparation or poor cooking before eating.
  - the immune system of the ingestor is not good and cannot fight the germ

For prevention, the principle of prevention of gastrointestinal disease is well known as Principles of Food Sanitation. The key to do in each step is herey described as followings.

1. Sanitation of raw materials.
   - a good raw material. no record for its origin is not good.
     - view the expiration date.
     - view source
     - see a standard in production
     - do not buy from places that are dirty
     - choose the quality, not choose because it is cheap or free.
     - do not use them without condiments
2. Sanitation of cooking
     - clean the cooking
     - avoid insects, ants or other pests.
     - set place for cooking in clean air and well ventilated
     - wash your hands before cooking.
     - clean all materials for cooking

The principles that should be followed during cleaning include

- clear up all terrible waste by running water
- potassium permanganate do not help much
- need to wash it (fruits and vegetables needs slowly wash, from the tip thorough to the lower lobe of each stalk)
  - screening for contagious disease in the ones who take responsible in preparation of food for sale
  - food must be well cooked, do not do a half-cooked.
  - clean the equipment for cooking before use
  - also clean the equipment after cooking.
  - the cook must have been vaccinated for the hepatitis B vaccine

3. Sanitation of eating

- eating only cooked food
- drinking new boiled water boiled
- bowls and food containers should be washed before use
- avoid fermented foods, poor cooked food and raw food, cook it
- wash your hands before eating
- wash your hands every time after eating.
- using the common teaspoon
- do not spit on the plate or container
- If you keep coughing, sneezing, avoide cooking and wash your hands before eating food

As a summary, the hand hygiene is very important.

The regular hand washing help effectively reduce the problem.

Hand washing is needed when [21- 22]

Touch food materials

Afer toileting

Before bringing things into your mouth

Before and after touching a patient

Returning home from outside

Contacting with dirty objects

In summary, the principles of food sanitation focus on these aspects

- Location

  To select the area that is good is required. That area must not destroy the environment of the location and is contaminated by dirt. It should also not cause nuisance problems due to smelt.

- Buildings used for cooking

  It must be strong and easy to maintain. It must have proper ventilation and must be clean. Clean regularly.

- Cooking or production

  It must be safe from any germs or toxins. Since the preparation, processing and packaging can be contaminated, there must be the well control process.

- Management and general cleanliness

  There must be a good management to maintain a clean container for food. Contact equipment must be cleaned up before use. The concern also includes management systems, waste treatment and proper management on disposal or waste resulting from the cooking as well.

- Quality control of raw materials and additives

  The choice of raw materials and additives must be gently done. The quality control is needed. • Personal hygiene.

  It is the most important issue because it is the most important thing that might let the disease spread widely.

- Animal health.

  Having and feeding pet is an activity that many people do it. Many pets may be a source of disease. The well management on pet sanitation and caring for its healh is required.

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